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(54) IMPROVEMENTS RELATING TO ELECTROFORMING OF FLUIDIC DEVICES

(71) We, THE PLESSEY COMPANY LIMITED, a British Company of 56 Vicarage Lane, Ilford, Essex, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to fluidic devices and has in view a method of manufacturing such fluidic devices in metal for use in applications where the devices will be subjected to relatively high temperatures which would otherwise be destructive of conventional plastics material fluidic devices.

According to the present invention there is provided a method of manufacturing a metallic fluidic device in which the device is formed in two parts one of which includes open channels and is made by electro-forming on a suitably contoured mould structure coated with an electrically conductive material, the one part after it has been formed to the requisite thickness being removed from the mould structure and the open channels formed therein being filled with wax or other filler material which can readily be removed from the device, in which the wax or other material is coated on its exposed surface with electrically-conductive material and the second part of the device providing closure walls for the open channels being formed by electro-plating a layer of metal over the coated filler and at least adjacent surfaces of the previously electro-formed part and in which the filler is removed from the completed device.

The electrically conductive material is preferably applied in suspension by spraying and one particular example of conductive suspension is colloidal silver suspension.

In the electro-forming of the device, in order to ensure that the walls of the channels of the device which converge on each other in close proximity so as to define narrow crevices between them are properly formed, it is preferred to employ so-called loss anodes in the plating process whereby the electrolyte is pumped through loss or sacrificial anodes and directed under pressure on to the regions of the mould where the channels converge to afford junction cavities. This serves to increase the density of plating metal in the region of the junction cavities and to force the metal into the crevices between the channel walls where the current density would normally be low.

By way of example one specific method of manufacturing a metallic fluidic device will now be described.

A mould of silicon rubber or acrylonitrile butadiene styrene copolymer which has on one surface thereof a raised pattern for defining the contours of what will be channels of the device, is cleaned, as by vapour blasting.

The mould is then sprayed with a colloidal silver suspension marketed under the name of "Disperson 915 Silver in M.I.B.K." This forms on the mould an electrically conductive coating preparatory to electro-plating and the coating is formed very quickly as compared with an electro-less method of forming an initial conductive coating which also suffers from the disadvantages that it requires heat with the result that distortion of the coating can take place when the structure cools upon completion of the process.

Electrical connections are provided to the conductive coating and the coated mould is suspended in a nickel plating bath and connected up as cathode. The plating bath includes so-called loss or sacrificial nickel anodes and a pump by which electrolyte is pumped through the loss anodes and to channel junction cavity regions of the mould pattern in order to ensure effective plating of the walls and converging channels at said junction regions.

When the desired thickness of wall has been built up the formed part of the fluidic device is removed from the mould and is cleaned, as by vapour blasting, to remove any excess of conductive coating material applied initially. The open channels in the formed part are then filled with low melting point wax and the silver suspension referred to previously is

applied to the wax only, as by spraying the whole of the formed part and then removing the excess from the surrounding nickel surfaces. The whole structure is then placed in an 80% solution of sulphuric acid which attacks the nickel but not the silver so as to provide an etched surface and thereby ensure good adhesion between the already formed nickel coating and that which is to be applied. The structure is then immersed in a further nickel plating bath and is nickel plated in order to provide closure walls for open channels in the already formed part. When the requisite thickness of nickel has been built up the structure is removed from the plating bath and holes are drilled into the structure at positions where the usual connecting pipes will be attached to the device. The wax filling of the completed channels or passage-ways of the device is then removed by heating the structure followed by pumping solvent around the passageways.

Although the mould referred to is preferably of plastics material it should be understood that other materials could be employed, such as metal.

WHAT WE CLAIM IS:—

1. A method of manufacturing a metallic fluidic device, in which the device is formed in two parts one of which includes open channels and is made by electro-forming on a suitably contoured mould structure coated with an electrically conductive material, the one part after it has been formed to the requisite thickness being removed from the mould structure and the open channels formed therein being filled with wax or other filler material which can readily be removed from the device, in which the wax or other material is coated on its exposed surface with electrically-conductive material and the second part of the device providing closure walls for the open channels being formed by electro-plating a layer of metal over the coated filler and at least adjacent surfaces of the previously electro-formed part and in which the filler is removed from the completed device.

2. A method as claimed in claim 1, in which the electrically conductive material is applied as a suspension to the mould by spraying.

3. A method as claimed in claim 1 or claim 2, in which so-called loss anodes are used in a plating process for electro-forming the device so as to ensure that the walls of the channels of the device which converge on each other in close proximity so as to define narrow crevices between them are properly formed, the loss anodes having electrolyte pumped through them and directed under pressure on to the converging walls of the channels.

4. A method as claimed in any preceding claim, in which the electrically conductive material is colloidal silver suspension.

5. A method of manufacturing a metallic fluidic device substantially as herein described.

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